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UNCLASSIFIED

WT 20-568

CAPTIVE DYNAMIC-STABILITY TESTS OF TWO APOLLO COMMAND-MODULE ABORT CONFIGURATIONS IN THE JPL 20-INCH SUPERSONIC WIND TUNNEL

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CAPTIVE DYNAMIC-STABILITY TESTS OF TWO APOLLO COMMAND-MODULE ABORT CONFIGURATIONS IN THE JPL 20-INCH SUPERSONIC WIND TUNNEL

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May 15, 1964

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I. INTRODUCTION

Wind-tunnel Test 20-568 was a test of two Apollo command-module abort-configuration models. The purpose of the test was to obtain dynamic-stability data for the two configurations. The approximate aerodynamic parameters for the test were Mach No. 0.30, 0.50, 0.70, 1.48, 2.01, 3.02, and 4.54, with corresponding Reynolds No./in. and dynamic pressures, as shown in Table 1. The test variables and ranges were initial angles of attack (α_0) from 0 to 180 deg.

The model configurations comprised (1) the Apollo command-module and escape-rocket tower, and (2) the Apollo command-module escape rocket and tower with flaps on the forward end of the escape rocket.

The test* was conducted at the Jet Propulsion Laboratory (JPL) from August 20 through 23, 1963, for the NASA Manned Spacecraft Center (Houston, Texas) which was represented during the test by Mr. B. Redd.

II. MODEL DESCRIPTION

The models are shown in Fig. 1 and 2. Both configurations were scale models of the Apollo command-module mounted on a ball-bearing support.

III. WIND TUNNEL

Reference 1 describes the construction and operating conditions of the 20-in. supersonic wind tunnel. The wind tunnel has a nominal test-section size of 20 in. square, a Mach range from 1.3 to 5.0, a flexible-plate nozzle, and operates with continuous flow. Table 1 presents representative values of the test-section flow parameters for the Mach numbers at which this test was conducted.

IV. TEST PROCEDURE

Prior to actual test operations, measurements were made to determine the moments of inertia of the models and the calibration sphere. The center of

*Symbols used in this Report are defined in the Nomenclature.

gravity of the calibration sphere was offset from the bearing axis. During a calibration run, the sphere was released 180 deg from its stable rest position. Analysis of high-speed motion pictures of the sphere's motion produced bearing-damping coefficients.

After moments of inertia and bearing-damping coefficients were obtained, the models were tested by (1) releasing them at various initial angles of attack and tunnel flow conditions and (2) simultaneously taking high-speed motion pictures of the two models' motions.

V. DATA REDUCTION

The data-reduction procedure is described in Reference 2 (JPL WT Report No. 20-499, Unclassified, which was published November 2, 1962).

VI. RESULTS

The actual data reduction was conducted by the Manned Spacecraft Center, and all motion pictures have been forwarded to them.

NOMENCLATURE

M	Mach number
q	dynamic pressure of the free-stream (psi)
α	angle of attack (deg); the angle between the longitudinal axis of the model and the centerline of the tunnel; α is 0 deg when the escape rocket and tower are upstream of the command module; α is +90 deg when the escape rocket and tower are vertically above the command module
α_0	initial, or release, angle of attack of the model (deg)

REFERENCES

1. Jet Propulsion Laboratory, California Institute of Technology, Wind-Tunnel Facilities at the Jet Propulsion Laboratory, Pasadena, California, JPL, January 1, 1962. (Technical Release No. 34-257) UNCLASSIFIED

2. Jet Propulsion Laboratory, California Institute of Technology, Results of the JPL Aerodynamic-Damping-in-Pitch Wind-Tunnel Program, by Duane A. Nelson, Pasadena, California, JPL, November 2, 1962. (WT 20-499) UNCLASSIFIED

[redacted]

Table 1. Average aerodynamic parameters

Parameter	Mach Number						
	0.30	0.50	0.70	1.48	2.01	3.02	4.54
Static pressure (psia)	7.92 14.4	2.86	1.39 9.66	0.33 1.66	0.23 0.35	0.08 0.54	0.04 0.69
Stagnation pressure (psia)	8.45 15.4	3.39	1.83 12.7	1.15 2.30	1.85 2.81	2.97 20.6	10.6 20.9
Dynamic pressure (psia)	0.50 0.91	0.50	0.48 3.34	0.50 1.00	0.66 1.00	0.50 3.48	0.50 0.99
Reynolds number (per in. x 10^{-6})	0.092 0.167	0.056	0.036 0.254	0.028 0.056	0.037 0.108	0.035 0.246	0.057 0.114

Note: When two sets of data are shown above, the first figure represents the minimum value; the second figure, the maximum value.

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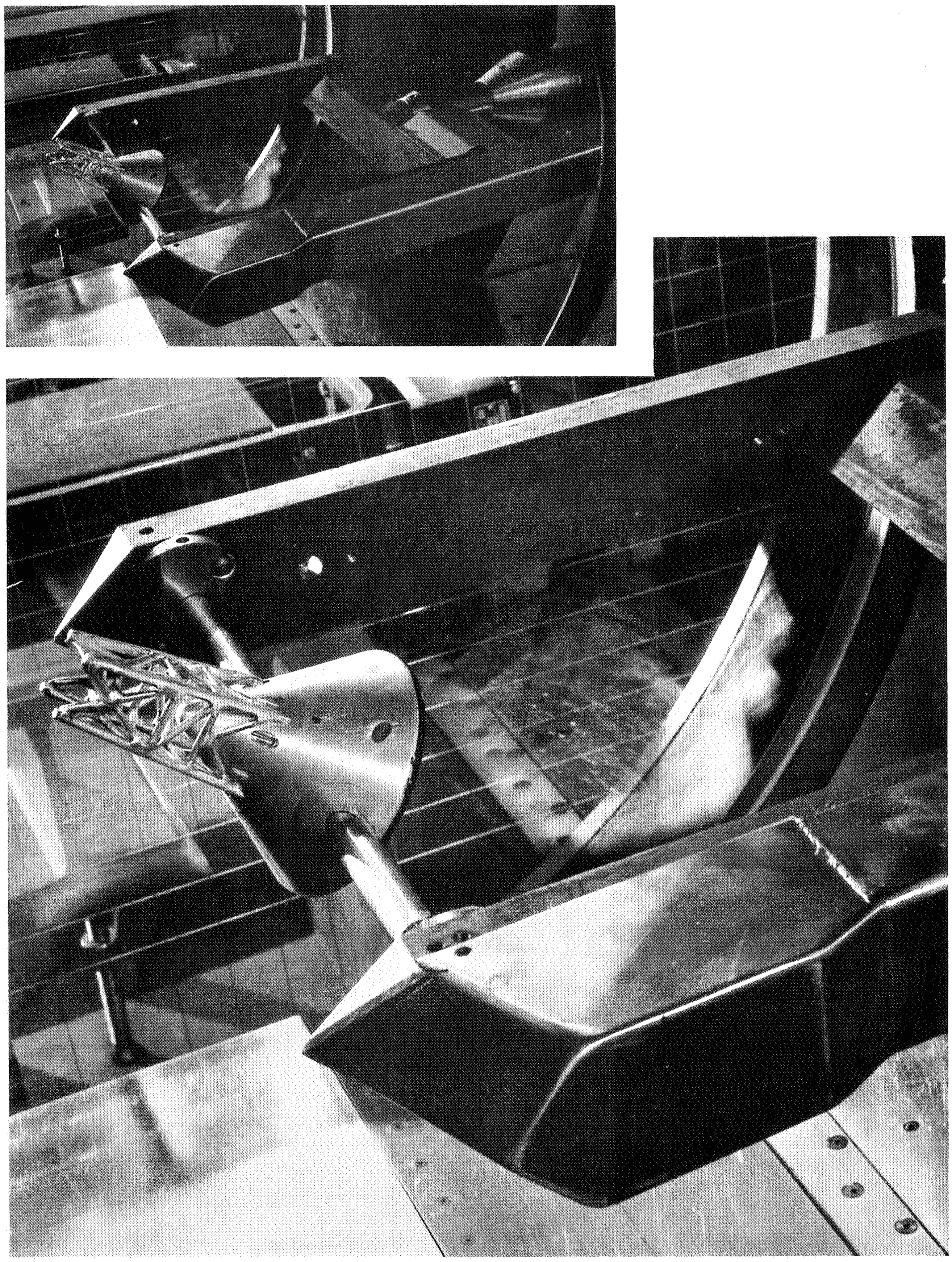


Fig. 1. Installation of Command-Module Tower Configuration

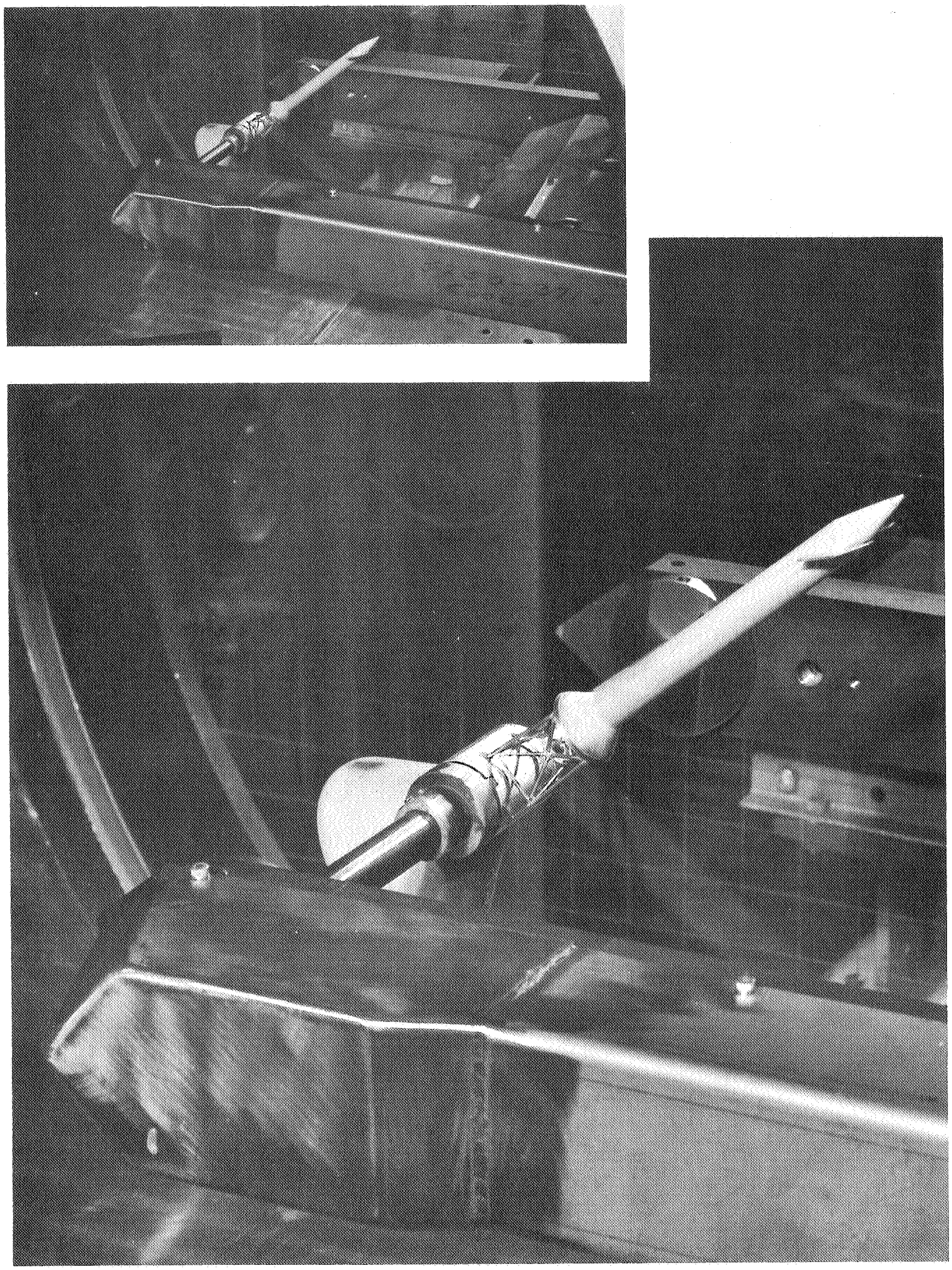
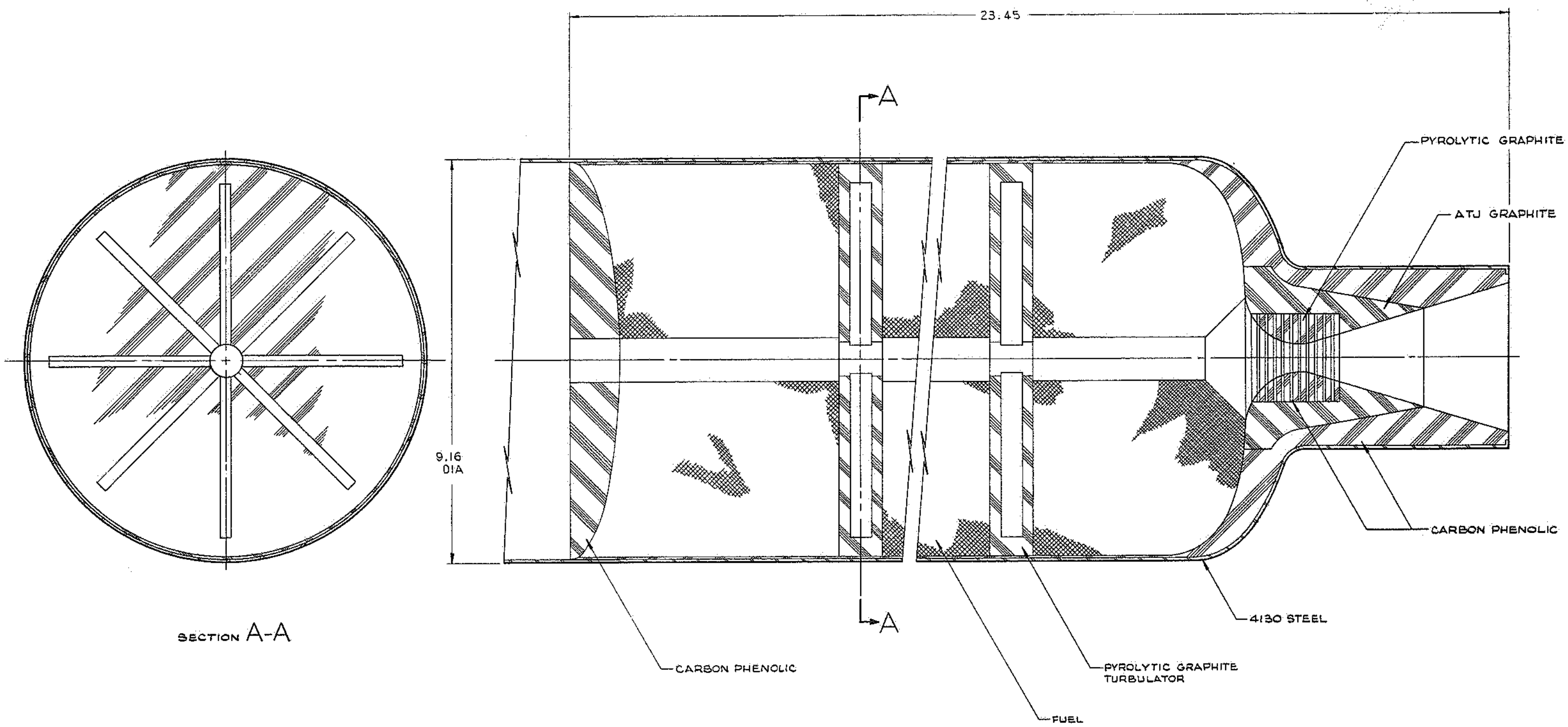


Fig. 2. Installation of Command-Module Tower-Flap Configuration



DEFINITION OF FOLLOW ITEMS DEPENDS
ON ALTERNATE CONCEPTS ARRANGEMENT.

1. OXIDIZER SOURCE.
2. INJECTOR AND INJECTOR SUPPORT.
3. FORWARD FUEL INSULATION SUPPORT.
4. MOUNTING PROVISIONS.

NOMINAL 500LBF X 95.5 SEC

FIG 3

AEROJET-GENERAL CORPORATION
SOLID ROCKET PLANT SACRAMENTO, CALIFORNIA

TITLE: ACS ENGINE HYBRID SHELL DESIGN

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
DECIMAL TOL XX ±.03 XXX ±.010 ANGULAR TOL ±-
DO NOT SCALE DRAWING

DESIGN N. NYLIN

CODE IDENT NO. 13310 | DWG SIZE E | DWG NO. 390619

SCALE 1/1 | SHEET 1